OFFICIAL FILE
ILL. C. C. DOCKET NO. 01-0701
IP Cross EXHIBIT NO. 4
WITNESS Eric Lounsberry
DATE 10-1-12 REPORTER [illegible]

Docket No. 01-0701
Staff's Response to
Illinois Power Company's
First Data Request
Revised Response

Directed to Eric Lounsberry

REQUEST #4:

Please provide all working papers relied on or used by Mr. Lounsberry in preparing ICC Staff Exhibit 2.00 and all attachments there to.

RESPONSE #4 (Revised):

Attached is a copy of Mr. Lounsberry's notes from the June 11, 2002 meeting at IP's headquarters, a copy of the Incident Report regarding the December 16, 2000 event at the Hillsboro Storage field, and photocopies of the relevant pages from the publications that Mr. Lounsberry cited in his direct testimony. The remaining workpapers are Illinois Power Company's responses to Staff data requests in this proceeding and in Docket No. 00-0714.

Other materials that Mr. Lounsberry has reviewed and conferences/seminars he has attended during his employment at the Commission that have provided him with information about the gas industry include the following:

Periodicals

Utility Safety
Underground Focus
Pipeline and Gas Journal
Gas Utility Manager
Hart Energy Market
American Gas
Public Utility Fortnightly

Other publications

InsideFERC
Natural Gas Intelligence – Weekly Gas Price Index
Foster Natural Gas Report

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RESPONSE #4 (continued) (Revised):

Books

Gas Engineers Handbook
AGA - Gas Engineering and Operating Practices Series – S-1 Underground Storage
AGS - Gas Engineering and Operating Practices Series – T-1 Pipelines/Planning and Economics
Oil and Gas Pipeline Fundamentals by John Kennedy
Natural Gas Underground Storage: Inventory and Deliverability by M. Rasin Tek
Natural Gas Purchasing Handbook by John M. Studebaker
Natural Gas in Nontechnical Language – Institute of Gas Technology by Rebecca Busby

Conferences/Seminars

NARUC Natural Gas Conference (February 1994)
American Gas Associated Operations Conference (May 2002)
Midwest Energy Association Distribution Roundtable (April 2001)
Midwest Energy Association Measurement and Controls Roundtable (April 2001)
LDC Forum-Gas Storage Strategies & Market Center Hubs (September 1996)
Energy Seminars Inc. – Natural Gas 101 (November 1997)
Energy Seminars Inc. – Gas Cost & Storage Incentive Mechanisms for LDCs (October 1994)
American Meter School – (Spring 1998)
World Energy Forum (May 2000)
Numerous seminars sponsored by the Institute for Regulatory Policy Studies

Mr. Lounsberry has also attended numerous Commission gas policy meetings that have discussed a variety of gas industry topics.

IP Visit 6/11/02

EPI Log by Western Atlas

Neutrons every spring/fall
gas saturation calculation

Similar to neutron logs.
used to calculate value of gas satur

$GIP = \phi S_g * A * h$

gives better S_g

EPI logs Ran @ Hillsboro

Shanghai – inv. verification did not find problem w/ Metering => accurate

@S => monitor pressure @ observation wells

# of years monitor wells did not ~~[illegible]~~ show gas, definitely prior to 99-00, ~~[illegible]~~
does not know prior.

Halliburton => Study in 2000, well treatment done in Oct/Nov 2001?

Shang F-5-A. treatment did not work.

TO do resin treatment this spacer.

Resin @ one of Hills bore as well.

Fire Marshal
Title 41
PART 200
Updated 71, 94

NFPA 59
adoption of latest code

Incorrect Stamp on Hills. on file under
Checked @ Shang- ~~for~~ found 12- problem

Kathy per Kurt will start
historical curves again in future

Natural Gas Underground Storage

Inventory and Deliverability

M. R. Tek
Professor Emeritus
The University of Michigan

PennWell Publishing Co.

age reservoirs directly affect verification of inventory and assurance of deliverability. That is why the inventory audits represent an indispensible component of any storage operation.

Evaluation of the performance of underground storage reservoirs involves recognition of three basic requirements called *performance attributes*.[1] These are:

- verification of inventory,
- assurance of deliverability,
- containment against migration.

The *inventory* represents the gas residing in the storage horizon. It is made up of two parts:

- base gas (or cushion gas)
- top gas (or working gas)

The *base gas*, part of which is physically or economically unrecoverable, remains in the storage horizon to provide the pressure energy necessary for withdrawal of top gas. The *top gas*, which is withdrawn and sold to markets during winter is replenished through injection every summer.

The *deliverability*, measured in terms of millions of standard cubic feet per day, is a storage attribute which relates to the ability of the storage field to deliver the gas to its dedicated market. It critically depends on the *equalized pressure* prevailing underground. Since the pressure is a function of the amount of gas in the storage container, it simply follows that deliverability is a function of inventory. If the container does not hold the gas, it becomes subject to the attrition of its inventory through the *migration* of gas.

Contained in the environment of the storage reservoir under positive pressure, and, lighter than other fluids sharing the pore space, the storage gas tends to migrate. Many factors can contribute to movement of gas away from the storage horizon. The pressure gradients, permeability of rock, integrity of caprock, geometry, fractures, faults, geological features, operating conditions, and equipment limits are among the many such factors.

For the purpose of this introduction, it should suffice to recognize and discern two kinds of storage losses:

- major losses across reservoir limits,
- minor losses sometimes called *seepage losses*.

The major losses may be due to caprock failure, unstable fingering, excessive over-pressure or other factors. There are diagnostic means for their detection as well as prognostic means for their remedy. The methodology used involves reservoir engineering, computer simulation, real-time monitoring, and periodic inventory audits.

The minor, but usually continuing, losses occur due to various causes.[1] Casing collar leaks, faulty mechanical joints, corrosion pin-holes, imperfect cement bonds, seepage from Christmas trees, venting, flaring, pipeline leaks, accidental blow-outs, unloading of wells, unmetered use in compressor stations are among examples usually cited. Such losses and "... gas otherwise unaccounted for" generically called seepage have been observed and estimated to range from a fraction of a percent to one or two percent per year of maximum storage capacity.

Seepage losses are sometimes too small to detect on annual or bi-annual surveys. Their cumulative effect, however, can be ascertained quantitatively through periodic inventory audits.

The present methods for periodic inventory audits may be listed as:

- volumetric method through shut-in pressure surveys,
- use of reservoir inventory-pressure data,
- graphical analysis of pressure-content plots.

1. The *volumetric method* involves integrating pressures over gas-filled pore volumes using estimates or calculations of expansion factors, sub-surface geometry, porosity, pressure transient analysis, and geostatistics. They provide calculation of gas-in-place which is compared to the book inventory to provide a cumulative loss or ineffective gas figure by difference.
2. The use of *reservoir performance data* permits calculation of the inventory from stabilized pseudo-pressures before and after injection/withdrawal seasons and the measured gas quantities. The industry standards call for the use of ΔQ equation and modified ΔQ equation developed by this author respectively for constant volume reservoirs and those subject to partial or full water drive conditions. Quite often, computer simulation, unsteady state or semi-steady

state, water drive calculations become necessary for reliable determination of inventory.

3. *Graphic analysis of pressure-content data* involves continual tracking of pseudo-pressures against the content in p/z vs I quadrant. Significance of slope and intercept of straight lines describing constant volume reservoirs or curved lines which exhibit the effect of water drive have been discussed in the literature by this author. Also included are the basic reasons for change of slope and parallel shifts.[1] Such graphical analyses, also called *"hysteresis performance"*, when used with proper data, permit useful interpretations to determine migration, seepage, and bubble growth. The use of hysteresis plots often require stabilized pressure data or a correlation of it in terms of observation well pressures.

Background

The background in underground storage of natural gas in the U.S. as of 1994 include some 3.1 trillion standard cubic feet of working gas in storage, capable of delivery on demand from practically every region in the country. Of this total amount, 568.3 BCF has recently been reported to reside in the Western Region[2] (The states ranging from Minnesota, Colorado, and Arizona to the Pacific Ocean). A major portion, about 1.8 TCF is located in the Eastern Region (The states which extend from the Midwest to Atlantic Ocean). The third and remaining working storage capacity, about 711 BCF resides in the Producing Region which includes the Gulf and central states of Texas, New Mexico, Oklahoma, Kansas, Arkansas, Mississippi, Louisiana. The base or cushion gas in storage which supports the 3 TCF plus nominal working inventory is in the range of about 4 TCF.

Among the states with large storage resources, Michigan ranks first with 559.5 BCF. California is the largest in the Western Region with 212.3 BCF. In the Eastern Region, Pennsylvania ranks next to Michigan with 386.4 BCF. The Table 1-1 summarizes data on underground storage capacities by states from a recently compiled, and published table by the *Oil and Gas Journal.*[2]

Before Order 636 producers had little, if any, incentive for underground storage. Since Nov. 1 1993 when Order 636 formally rec-

ognized the market-based
demand imbalances led to c
jects with quick response st
age, upstream of pipelines a

Table 1-1 Underg
(Standard BC

State	Base Gas
Alabama	2.6
Arkansas	21.5
California	246.2
Colorado	46.1
Illinois	584.5
Indiana	112.6
Iowa	204.2
Kansas	240.2
Kentucky	105.3
Louisiana	265.2
Maryland	46.6
Michigan	411.5
Minnesota	4.6
Missouri	21.6
Mississippi	73.2
Montana	167.3
Nebraska	50.0
New Mexico	3.7
New York	90.1
Ohio	334.2
Oklahoma	172.9
Oregon	4.9
Pennsylvania	355.1
Texas	231.6
Utah	64.1
Washington	16.8
West Virginia	294.9
Wyoming	60.7
Total U.S.	4,211.3

Source: Summarized from Table
Publishing)

PART TWO

DELIVERABILITY

". . . Deliverability is always there until when you need it."—
Bill O'Farrel, Manager Gas Control, ret., Questar Pipeline Co. Salt Lake City, Utah

Assurance of Deliverability—Introduction

Deliverability is a measure of the rate at which the storage gas can be sent to its market. It is also the rate at which the pipeline gas can be injected into the storage field.

Deliverability involves steady and unsteady-state flow into the wellbores, through the production strings and through the surface gathering system. While *inventory* is like money in the bank, *deliverability* is analogous to cash flow in deposits and withdrawals.

Deliverability is related to inventory in general and to the extent of cushion gas in particular, simply because it is a function of the pressure level in the reservoir.

In storage operations, the ability to deliver the gas to the market is usually far in excess of market demand during early season. During late winter, on the other hand, inventories become depleted and the deliverability begins to drop. This, unfortunately happens at a time when the demand for gas increases, but there are several strategies designed to meet these difficulties. Use of other resources such as LNG, close spacing with areas of high well density, certain withdrawal strategies, line packing, gas swaps and storage withdrawal from salt cavities are typical alternatives.

The calculations developed for predicting the deliverability from storage involve both flow through the drainage matrix around the wellbores and flow through production strings and surface

INCIDENT REPORT

OFFICIAL FILE
ILL. C. C. DOCKET NO. 01-0701
IP Cross 5 EXHIBIT NO.
WITNESS Eric Lounsberry
DATE 10-1-02 REPORTER

Location:	Illinois Power Company Hillsboro Storage Field Irving, Illinois
Date of Incident:	December 16, 2000
Date of Inspection:	December 18, 19, & 20, 2000
Purpose:	Incident Investigation at Rural Route 1, Box 60 Irving, Illinois 62051
Person(s) Contacted:	Bob Barcum, Manager Gas Storage Operations Don Johnson, Manager Gas Quality Program Bill McKinney, Senior Director Gas Supply Ken Thacker, Plant Forman Dennis Jagodzinski, Gas Journeyman Dennis Spencer, Claims Representative Kevin Reinert, Claims Representative Russell Ogle, Vice President, Chemical Engineering (Packer Engineering)
Conducted by:	Charles Gribbins, Pipeline Safety Analyst III

Statement of Activities

Synopsis

On December 16, 2000, while manually operating the dump valve on a water separator at the Hillsboro Storage Field Plant Facility, natural gas under 1,190 psig of pressure, entered a 50,000 gallon water storage tank with a roof, causing the base of the tank to fail and launching the tank 275' feet. The tank landed on top of the regulator station building located inside the plant, causing major damage to the station. It also caused major damage to the cable control systems, and dehydration towers. No injuries or fatalities were reported. The incident resulted in approximately $1,000,000 in damages.

Facilities Involved in the Incident

Separators:

As the gas leaves the plant, it flows through separators to remove moisture. The gas passes through a series of baffles inside the separator housing, causing moisture in the gas to drop out. The water drops collect in the bottom of the separator. When the water reaches a set level, a float mechanism inside the separator activates a switch, which in turn energizes the controller for the dump valve. Gas at a pressure of 1,190 psig, forces the water out of the bottom of the separator tank and into the water-holding tank. There are thirteen other smaller separators that dump water from well sites into the same holding tank. The thirteen well site separators dump at pressures of only 100# p.s.i.

Water holding tank:

The water holding tank has a 50,000gallon storage capacity. The tank has a 24" vent in the roof with a flapper type lid, which is used for pressure relief. The holding tank also has a 6" vent line with a screen over the outside opening, and a 3" overflow line on the side of the tank. The holding tank was not designed as a pressure vessel and according to Packer Engineering Studies, it was only designed to handle no more than 5 psi of pressure before failing. The tank was also designed with a heating coil to prevent the stored water from freezing. Post accident inspection of the heating coil found no indications that it was not functioning properly at the time incident.

Incident

Normally the storage field & plant is not manned at night, however, due to the extreme weather conditions on December 16, 2000, two plant personnel were working to continuously monitor plant withdraw operations. The temperature was 4 degrees above 0, the wind was blowing out of the northwest at about 19 miles per hour, gusting to 28 m/h, and only hours earlier there had been a freezing rain.

At approximately 9:00 p.m., one of the employees left and went home, leaving the plant foreman at the plant alone. Around 11 p.m., while conducting a routine inspection, the foreman observed that the re-boiler was out. He re-lit the re-boiler and then observed a high water level in the site-glass on one of the two water separators. He turned up the sensing control switch on the automatic controller to energize the water dump valve. The dumping process uses natural gas under a pressure of 1190 psig to force water from the bottom of the separator to a holding tank located outside the fenced in area of the plant. The foreman stated that approximately 10 seconds after turning up the sensor control switch he heard an explosion noise over near the regulator station building. He immediately activated the plant's Emergency Shut Down System (ESD), which shut down the plant. He then ran to the maintenance office building, called the Decatur based Gas Pressure Control to inform them of the problem. He requested they contact the Manager of Storage Field Operations and to send help. According to Illinois Power's computerized storage field monitoring system, the ESD System was energized at approximately 11:50pm.

It was later learned that the 50,000 gallon water holding tank had launched from its location outside the plant fencing, traveled some 275 feet, and landed on the regulator station building destroying the structure. While the tank was in flight, it also took out the above ground cable run used for monitoring and controlling plant operations.

Post Accident Investigations

On December 18, 2000, the Illinois Commerce Commission, Illinois Power Company Claims Department, and Gas Supply Representatives met at the storage field & plant to assess the damage.

On December 20, 2000, Packer Engineering arrived to examine plant facilities to determine what was the cause of the incident. Packer Engineering found the tank in two major pieces, consisting of the bottom plate as one piece and the tank walls and roof dome as the second piece. The walls and dome of the tank were found to be largely intact, although crushed from the impact with the regulator station building. No tears or penetrations were found in the tank. Packer examined the bottom plate, which was still attached to the concrete pad, and they determined that the tank failed circumferentially in the weld that connected the walls of the tank to the bottom plate.

They determined that only two things could have happened to cause the tank to fail and launch into the air, the ignition of a natural gas and air mixture or the over pressurization of the tank. The natural gas ignition was ruled out due to the absent of an ignition source in the area of the tank, lack of thermal damage and lack of soot deposits. However, the over pressurization of the tank was consistent with the damages observed and the sequence of events immediately prior to the launching of the tank.

Illinois Commerce Commission Staff conducted interviews with plant operating personnel and was informed that it was not uncommon to manually dump the water out of the separator by advancing the sensor adjustment knob on the control panel to activate the dump valve for about 5 to10 seconds while monitoring the water level in the site-glass as the foreman stated he had done the night of the incident. However, to overpressure the holding tank you would assume that the separator would almost be empty of liquids before allowing gas to enter the piping system to the tank. Engineering calculations shows that it takes 10.9 seconds to dump 25 gallons of liquids from the separator. It is also assumed that if the site-glass was at the high water level as stated by the foreman, there had to be more than 25 gallons, considering the size of the separator. The site-glass level reading was never confirmed before the separator was torn down in the post accident equipment inspection. Maintenance personnel could not remember how much liquid was removed from the separator during teardown, but did state that some liquids were removed. While the separator was draining, they were busy dismantling other parts of the separator.

The teardown and inspection of the separator found nothing that would prevent the separator from functioning properly. The inspection and testing of the dump valve also found no indication of a malfunction.

Packer Engineering determined that the holding tank was only designed to withstand no more than 5 psi buildup of pressure before failing. However, based on the critical flow of the dump valve and the operating pressures involved, the 24" man way vent had almost forty times the relief capacity needed to maintain tank integrity. The 6" vent opening had more than twice the relief capacity needed, and the 3" vent line had a little more than half the relief capacity needed to maintain tank integrity.

Conclusions

Although it would be highly unusual, one scenario is that the freezing rain condition, strong winds and cold temperatures mentioned earlier, may have caused ice to form on the outside of the tank, preventing the flapper on the man way from functioning properly. In order to overpressure the tank, ice would also need to seal off most of the 6" vent line. The freezing rain that occurred the night of the incident was not considered significant. There were no downed power lines or power outages resulting from the freezing rain.

The other scenario is that high-pressure gas had been bubbling up through the water in the tank for some time, a lot longer than the 10 seconds described by the foremen. The splashing water and foaming conditions may have caused ice to form on the cold metal walls of the inside of the tank blocking off the 6" vent line and sealing the flapper closed.

In either scenario, high-pressure gas entering the tank, and the most likely source of that gas is from the separator, when the foreman manually operated the dump valve.

The Packer Engineering Report concluded that: The cold weather, accumulation of ice and high winds contributed to this event. The cold weather could cause the materials within the dump valve to resist movement. Therefore, the valve might not perform as quickly as designed during extreme conditions. The accumulation of ice and /or high wind likely restricted the opening of the man way vent, thereby depriving the tank of its designed pressure relief.

Testing conducted on the dump valve several days after the incident found no problems with the response of the valve.

The Packer Report went on to say that, their preliminary conclusion was that the 50,000 gallon water tank failed because of the rapid build-up of high-pressure gas within the tank, and the probable cause of the failure was the manual operation of the separator dump valve by the plant Foreman during the extreme cold weather.

Recommendations

Packer Engineering recommends that Illinois Power Company carefully examine the procedure for manually dumping the water-gas separator and consider modifying this procedure to prevent a recurrence of this incident.

Packer Engineering offered the following recommendations to prevent a reoccurrence of this incident.

- Visually inspect the tank to insure venting is not obstructed prior to manually dumping separator.

- Don't initiate manual dumping of separator during extreme weather conditions.
- Rapidly cycle manual dump valve open and closed during dumping of separators to minimize volume of gas that can enter tank.

Staff Recommendations

The probable cause of this incident was the manual operations of the dump valve controls. The sensing controls should be set at the proper water level depths and should not be tampered with. If it is clear that it has malfunctioned by the excessive water build-up in the bottom of the separator, the separator unit should be shut down and examined to determine the cause of the malfunction. Manual dumping should be limited to only extreme cases of controller failure, and should be rapidly cycled under close observation as recommended by Packer.

CJG/ns
100501

IP Visit 6/11/02
EPI Log by Westem Atlas

Neutrons every spring & fall
gas saturation calculation

Similar to neutron log.
used to calculate value of gas saturation

$GIP = \phi S_g * A * h$

gives better S_g

EPI logs Run @ Hillsboro

Shanghai - no, verification did not find problem w/ Metering → accident ...

@S → monitor pressure @ observation wells

# of years monitor wells did not ~~show~~ show gas, definitely prior to 99-00,
does not know prior.

Hallburton → Study in 2000, well treatment done in Oct/Nov 2001?

Shang F-5-A treatmt did not work.

TO do resin treatmt this year.

Rosin @ one of Hills kve as well

Fire Marshal
Title 41
PART 200
Updated 71, 94

NFPA 59

adoption of latest code

Incorrect Stamp on Hills, orifice under
checked @ Shang- ~~for~~ K- problem
found

Kelly per Kurt will start
hysteresis curves again in Fedora